CERES Instrument Status
Flight Models 1 -5 (FM1 – FM5)

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CERES Science Team Meeting
NASA Langley Research Center
Hampton, Virginia
May 15, 2018

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CERES Instrument Operations: FM1 - 5

CERES Instruments, Flight Models 1- 5 (FM1 – FM5) are primarily operating in cross-track mode.

A new calibration sequence was developed and uploaded to all CERES instruments. The new sequence will utilize the use of Shortwave Calibration source through one cycle during internal calibration.

Inter-comparison Operations for Summer 2018

CERES Terra/FM1 – S-NPP/FM5: May 1 – July 31, 2018.

CERES Terra/FM1 – JPSS-1/FM6: May 1 – July 31, 2018.

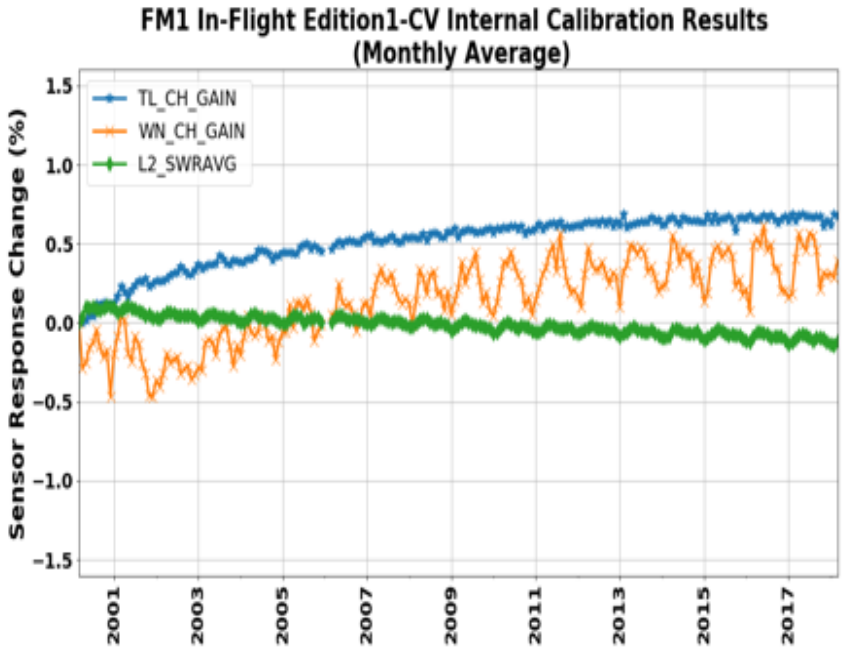
CERES Terra/FM1 – Aqua/FM3: June 1 – June 30, 2018

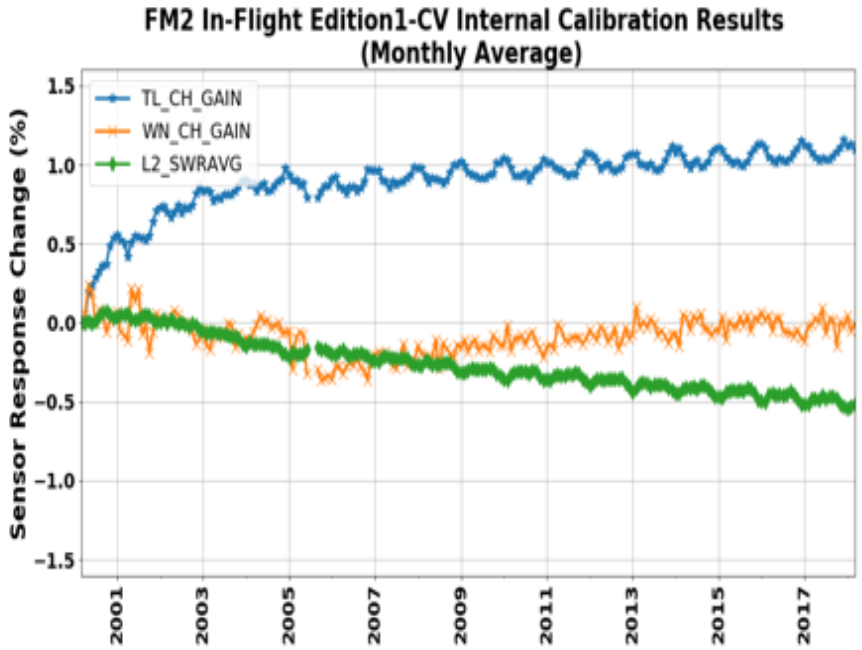
TERRA & AQUA INSTRUMENT STATUS

[CERES FM1 – FM4]

Terra CERES FM1 & FM2 Instrument Calibration

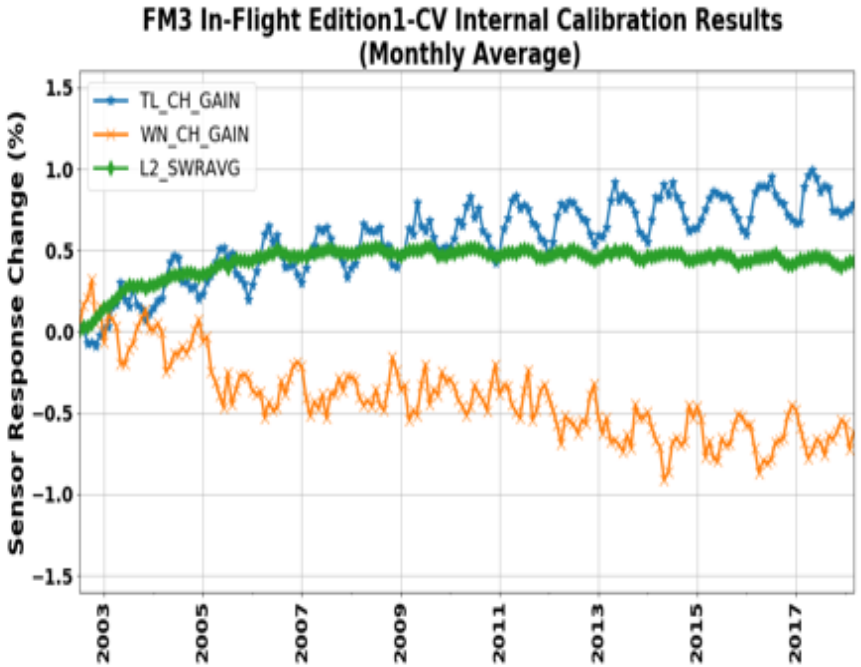
- **Increase in response for Total and Window sensors**
- **Drop in response for SW sensors.**

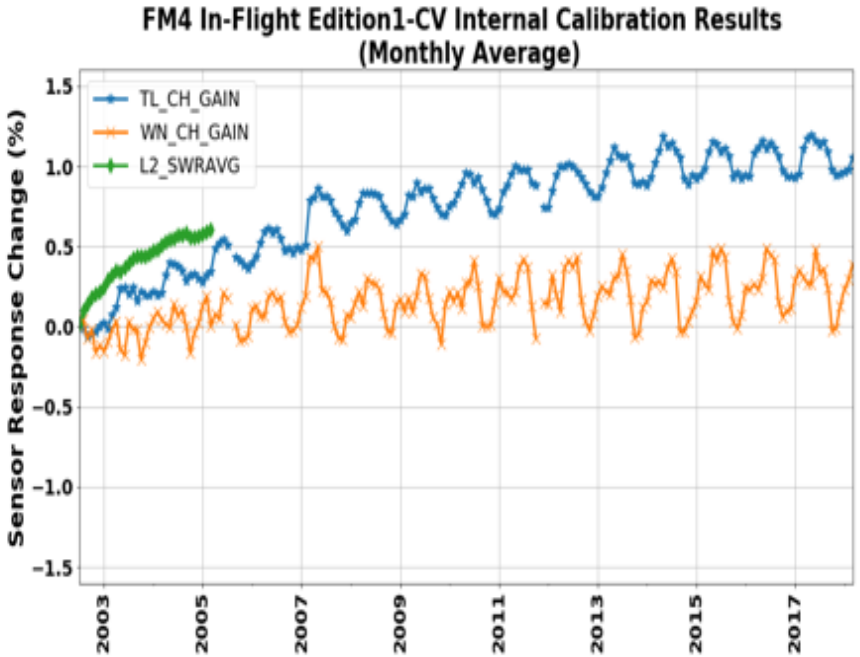




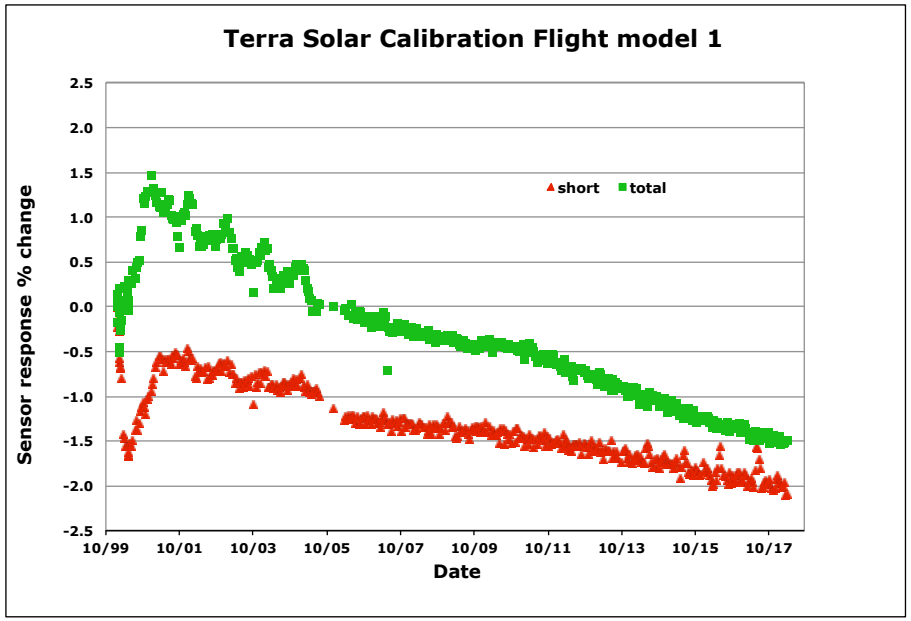
Aqua CERES FM3 & FM4 Instrument Calibration

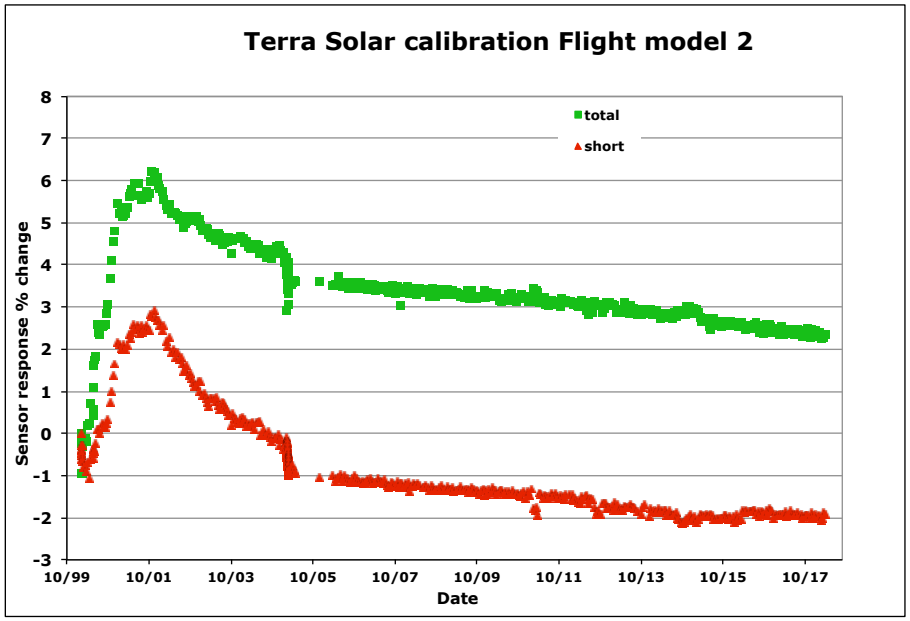
- **Increase in response for Total and SW sensors.**
- **Window sensor on FM3 showed a drop where as FM4 response show slight upward trend, similar to FM1 and FM2 instruments.**





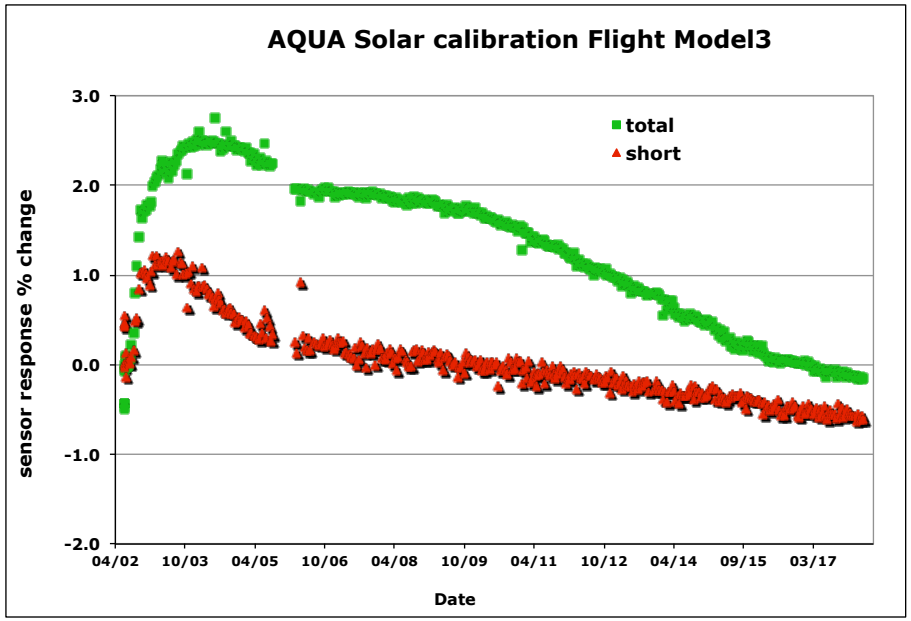
Terra FM1 & FM2 Solar Calibration Results

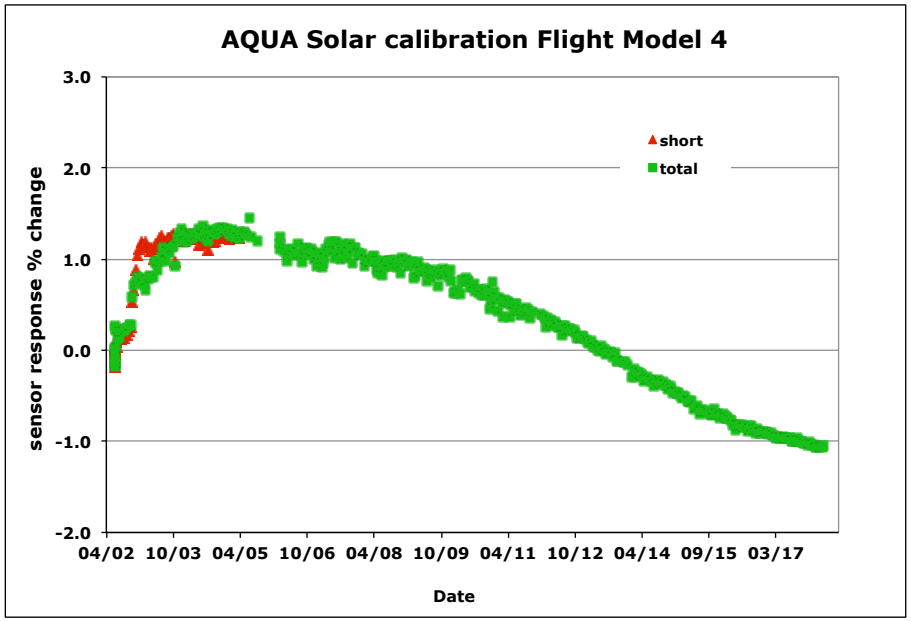




- **Mirror Attenuator Mosaics (MAMs) on FM1 & FM2 instruments showed huge throughput change in first two years of Mission.**
- **With the new solar raster scan calibration sequence starting Dec 2005, the MAMs showed slower rate of change.**

Aqua FM3 & FM4 Solar Calibration Results





- Mirror Attenuator Mosaics (MAMs) on FM3 & FM4 instruments also showed increase in throughput for first 18 months in Mission.
- The total sensor responses on both instruments showed a drop of 2 percent after the new solar raster scan calibration sequence started in Dec 2005.
- SW sensor on FM3 instrument showed about one percent drop in response.

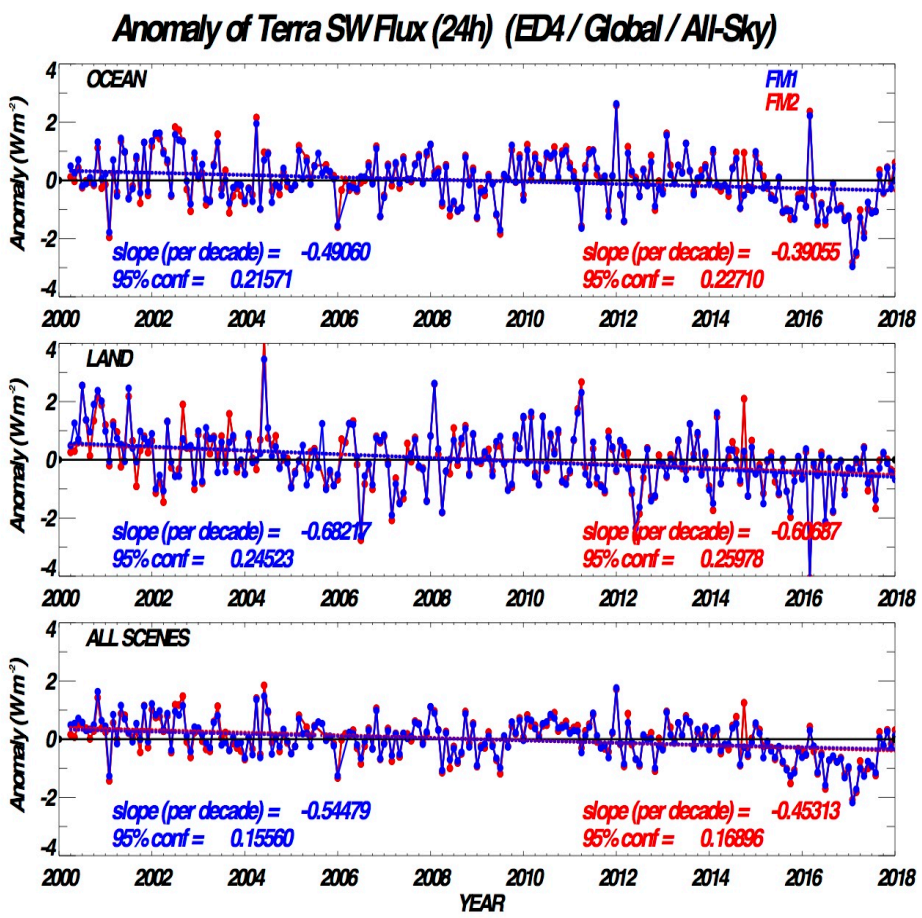
TERRA/AQUA Edition4 GAIN and SRF

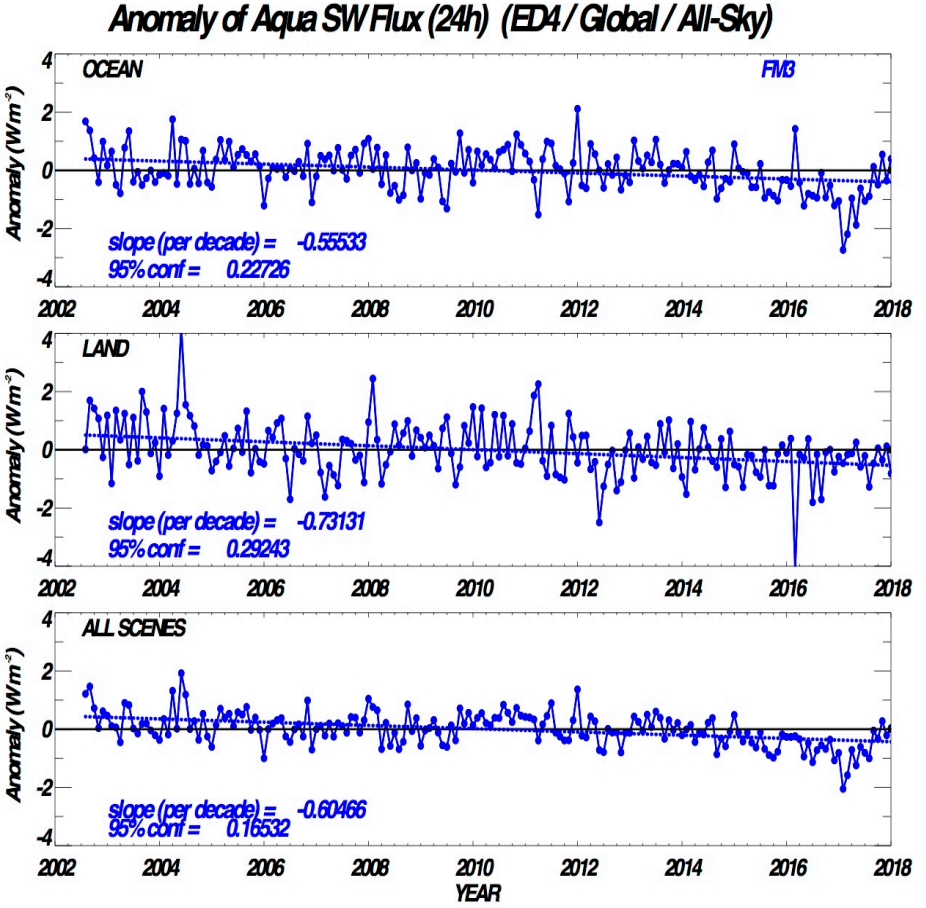
- **Edition4 Gains and Spectral Response Functions (SRF) :**

  Terra and Aqua - Start of Mission to January 2018

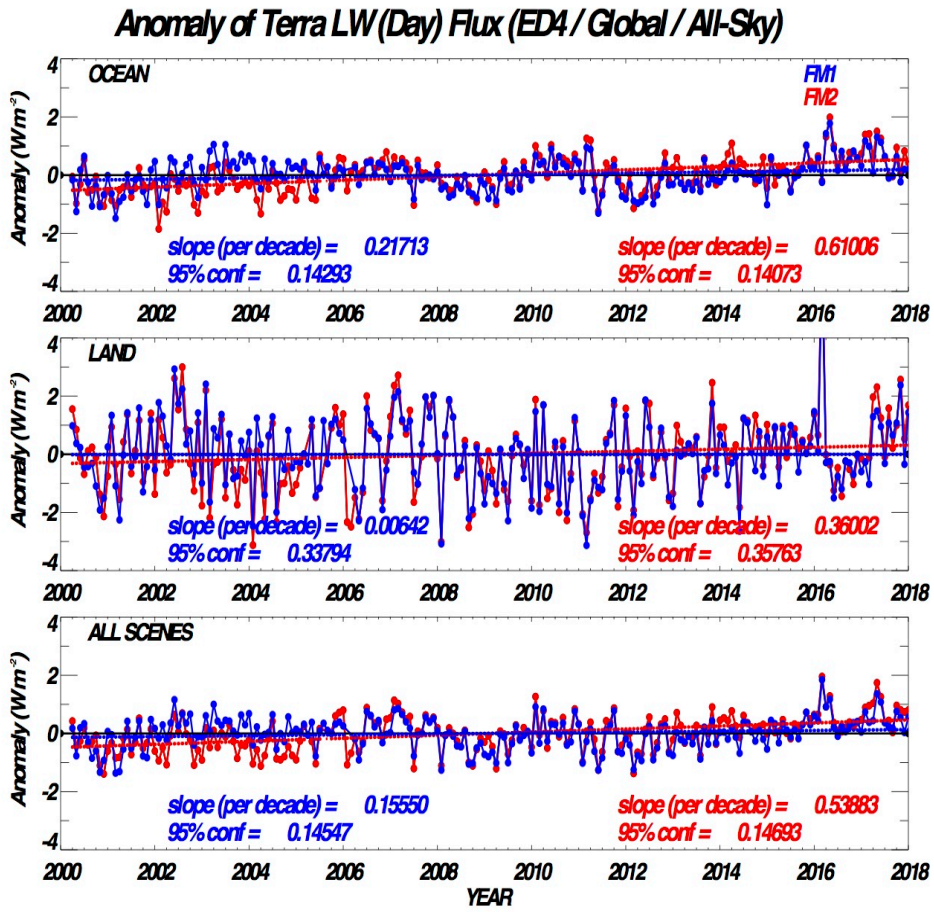
- **The monthly Gain values for the Total, Window and Shortwave sensors are based on in-flight ICM calibrations.**
- **With both instruments on the spacecraft operating in crosstrack mode, the current monthly SRF corrections for SW sensor remain constant.**
- **SRF correction in SW/TOT sensor is calculated monthly using All-sky Ocean and Land measurements of LW and Window sensors.**

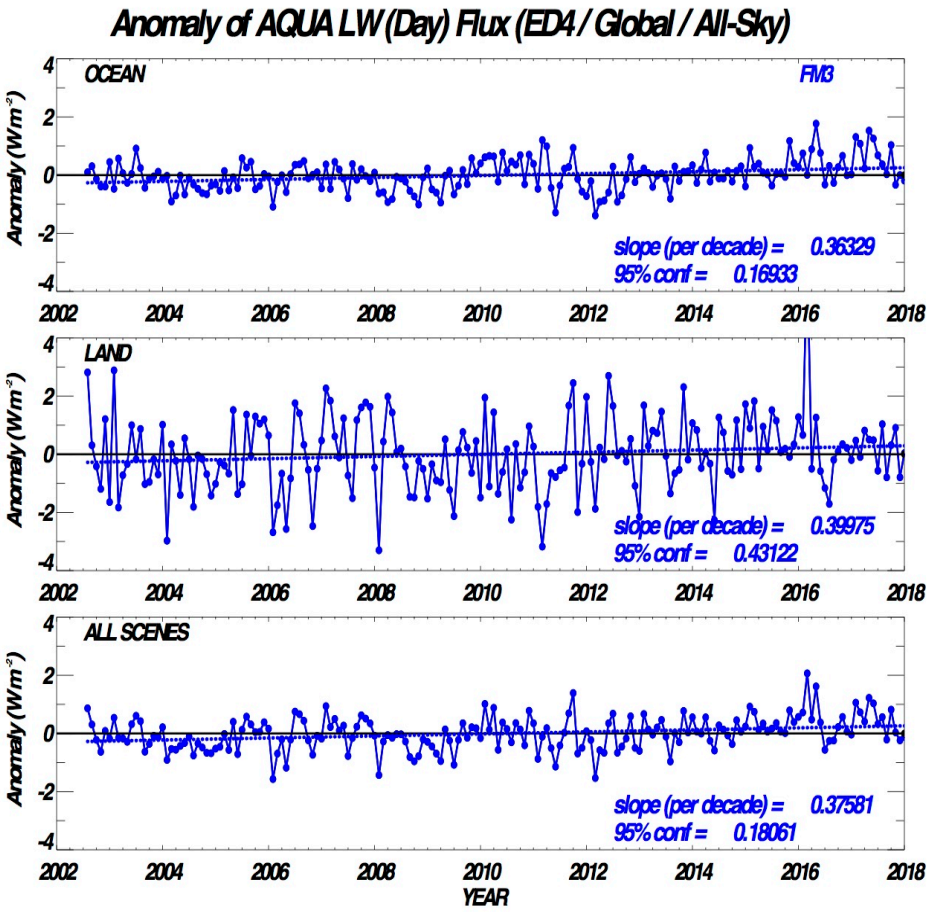
EDITION-4 RESULTS: TERRA & AQUA SW SENSORS



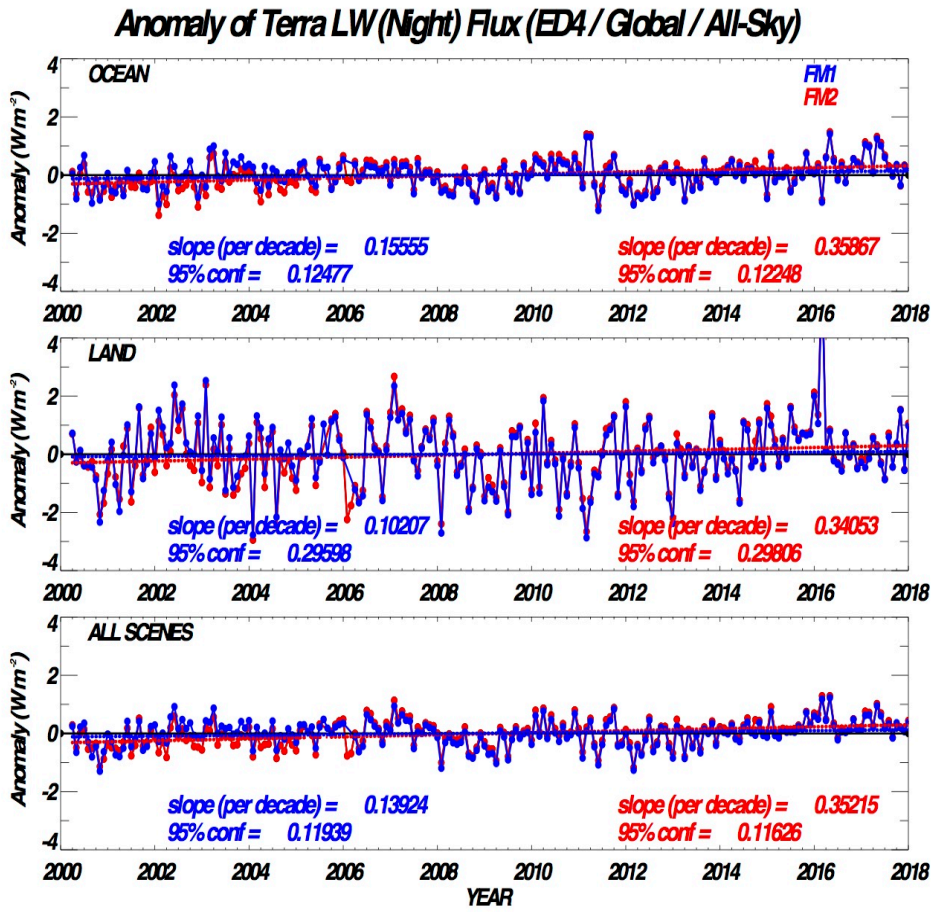


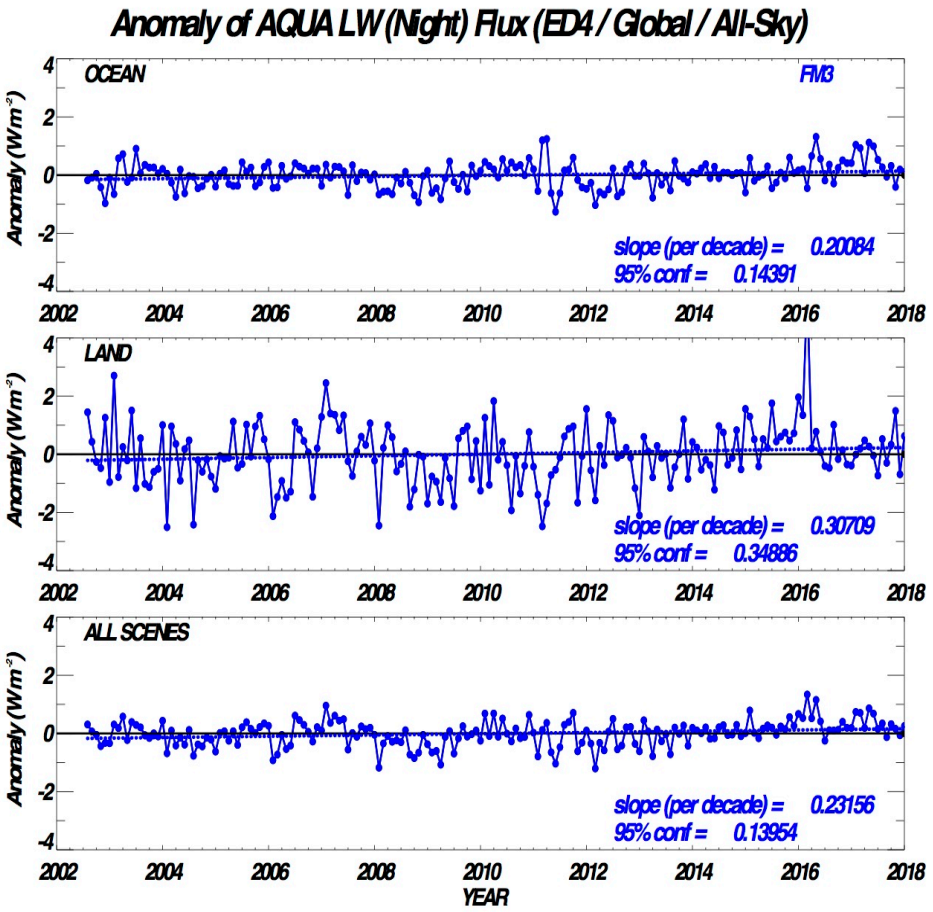
EDITION-4 Results: TERRA & AQUA LW_Day Flux





EDITION-4 Results: TERRA & AQUA LW_Night Flux



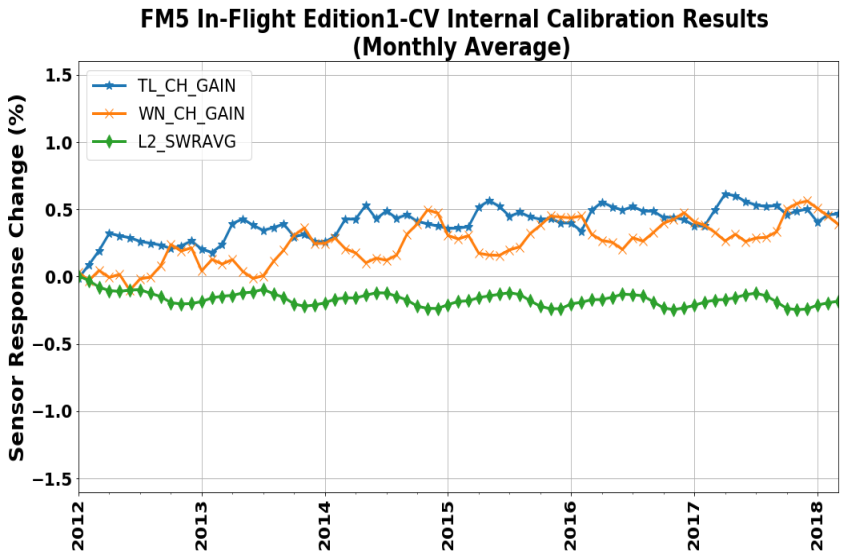


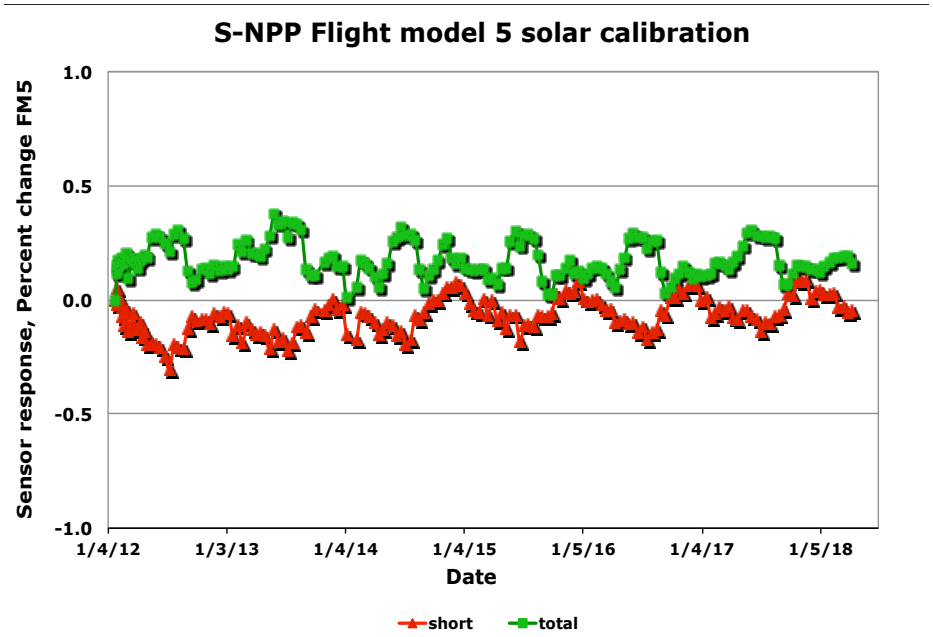
S-NPP/ CERES FM5 INSTRUMENT STATUS

S-NPP CERES FM5 Instrument Calibration

ICM calibrations show a response increase of 0.5% for Total and Window sensors. SW sensor shows an initial drop of 0.2%

Solar calibration results: SW sensor shows slight rising trend. Total sensor is steady

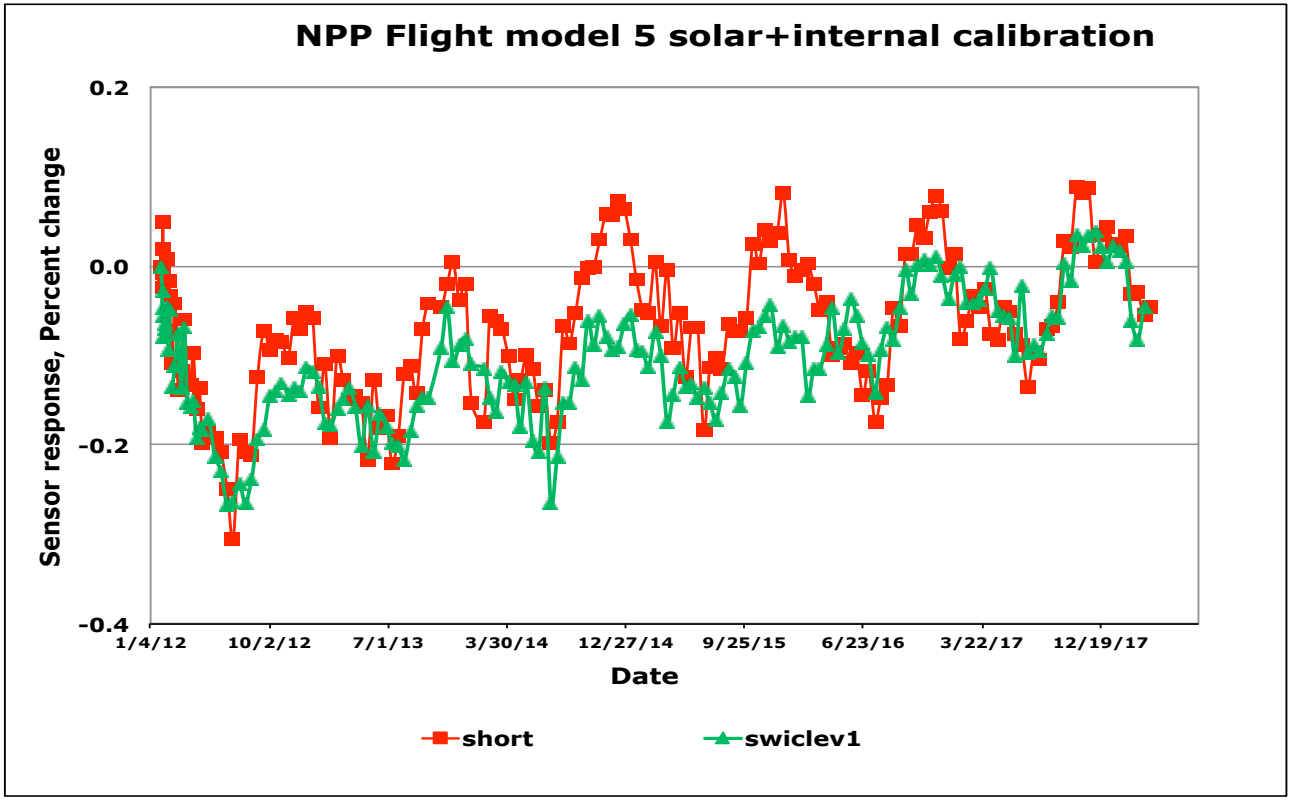




Sensor gain corrections based on ICM calibrations are applied to Edition1 data products.

S-NPP/CERES FM5 Instrument Calibration

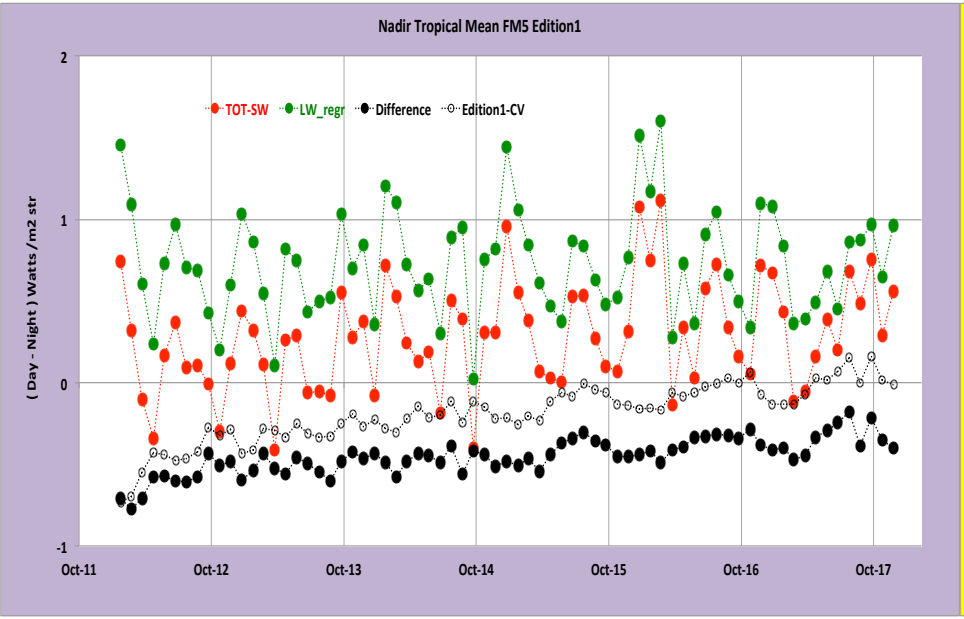
Comparison of calibration results from SWICS (Level1) and MAM showed similar trends in the SW sensor.

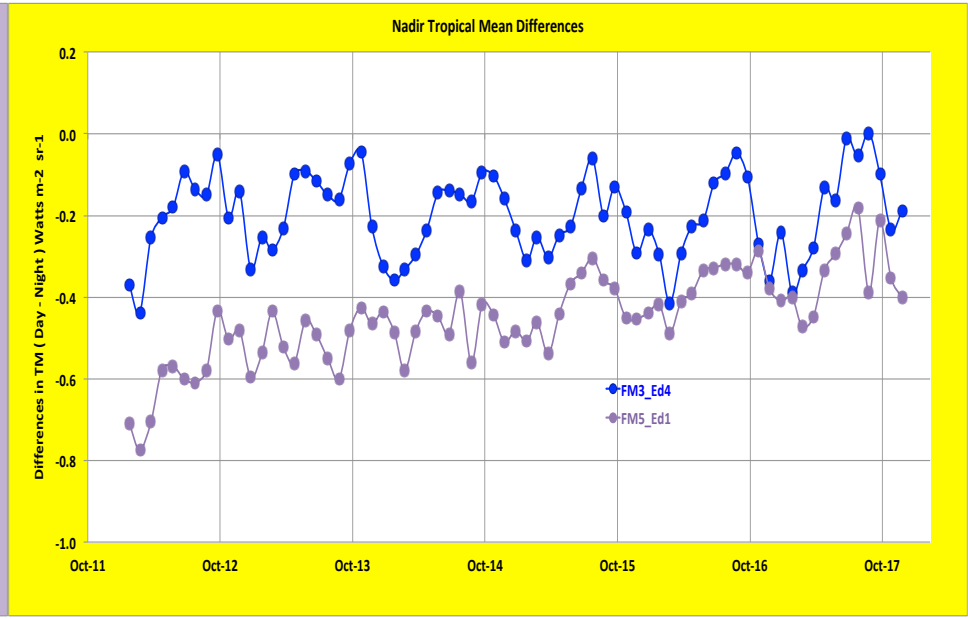


S-NPP/CERES FM5 Validation Results

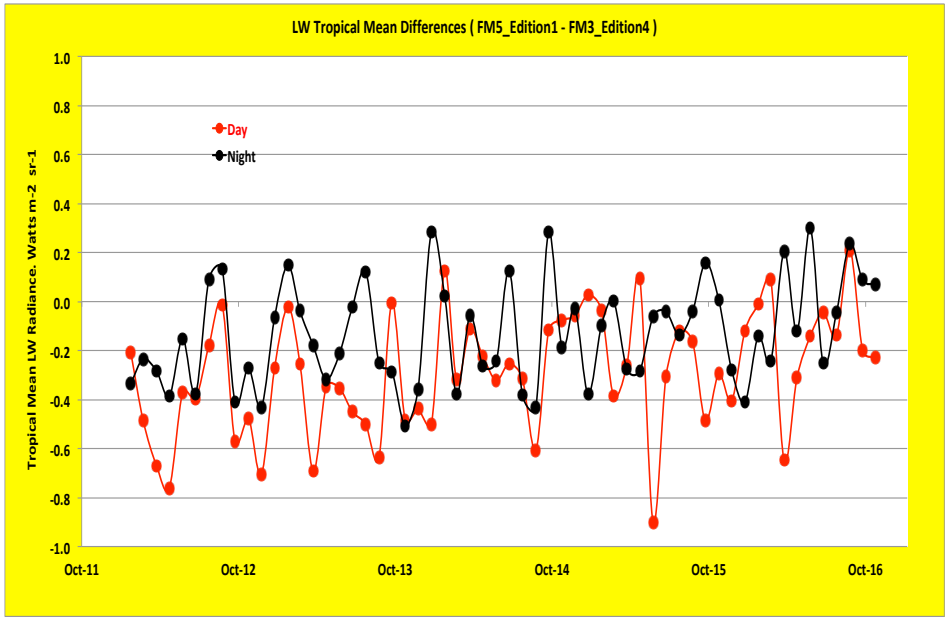
Tropical Mean (TM): Nadir LW radiance for All-sky Ocean in ± 20 deg Latitude. Changes in SW/TOT channel is monitored through Day-Night (DN) Difference comparison between LW and Simulated LW from Window measurements.

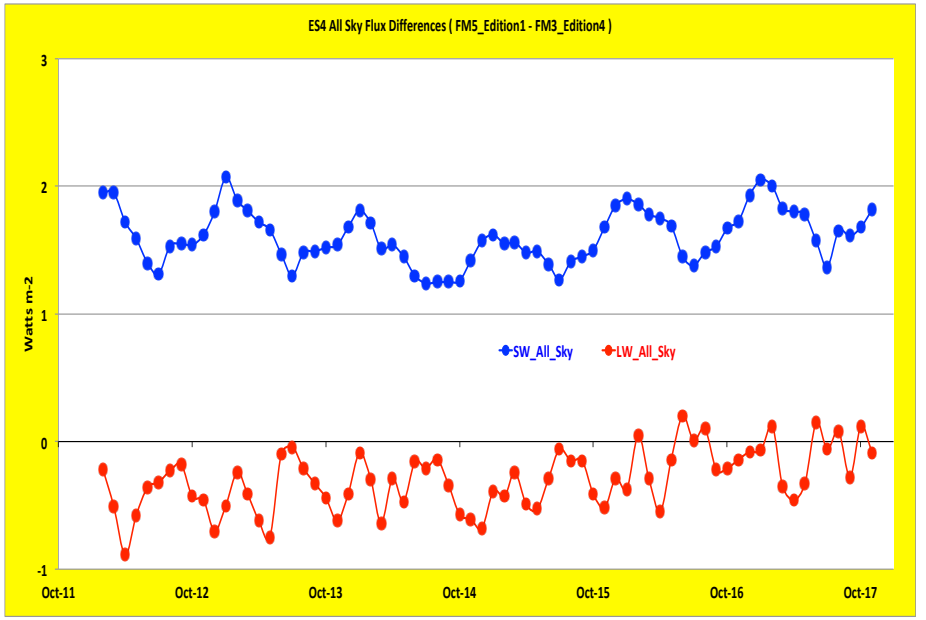
DN Difference comparison of FM3 Edition4 with FM5 Edition1 results show slight increase in FM5 results, which can attribute to change in SW/TOT sensor.





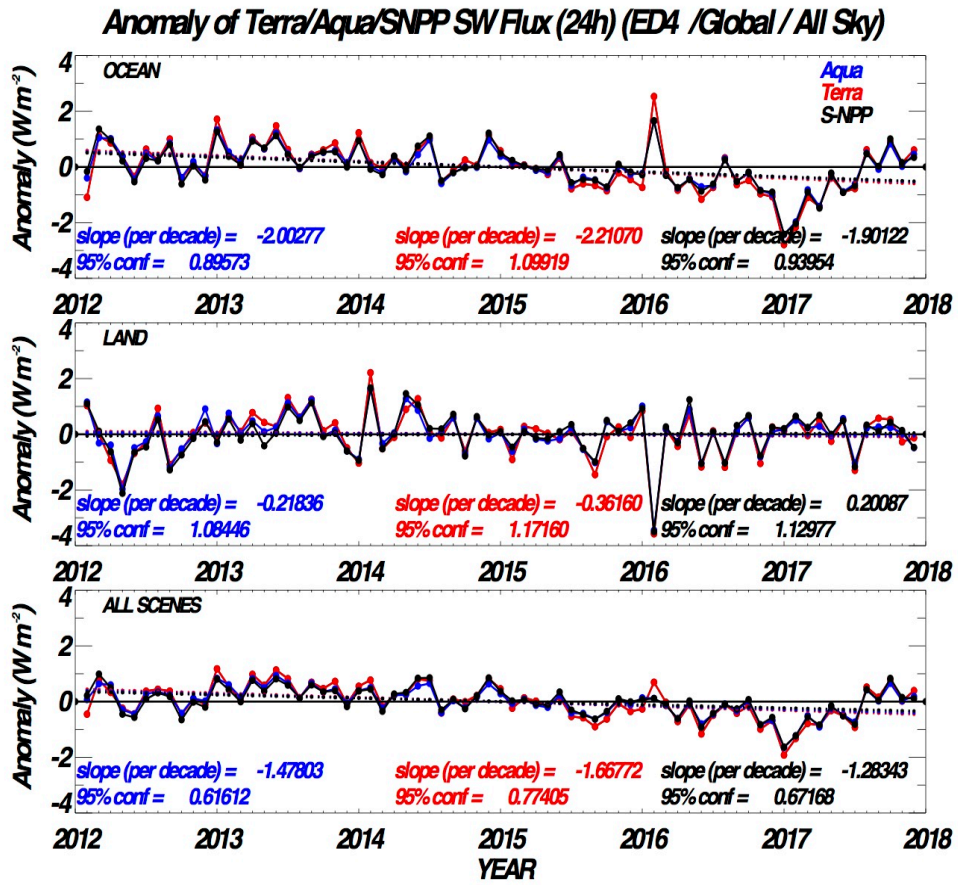
CERES S-NPP/FM5 – Aqua/FM3 Comparison

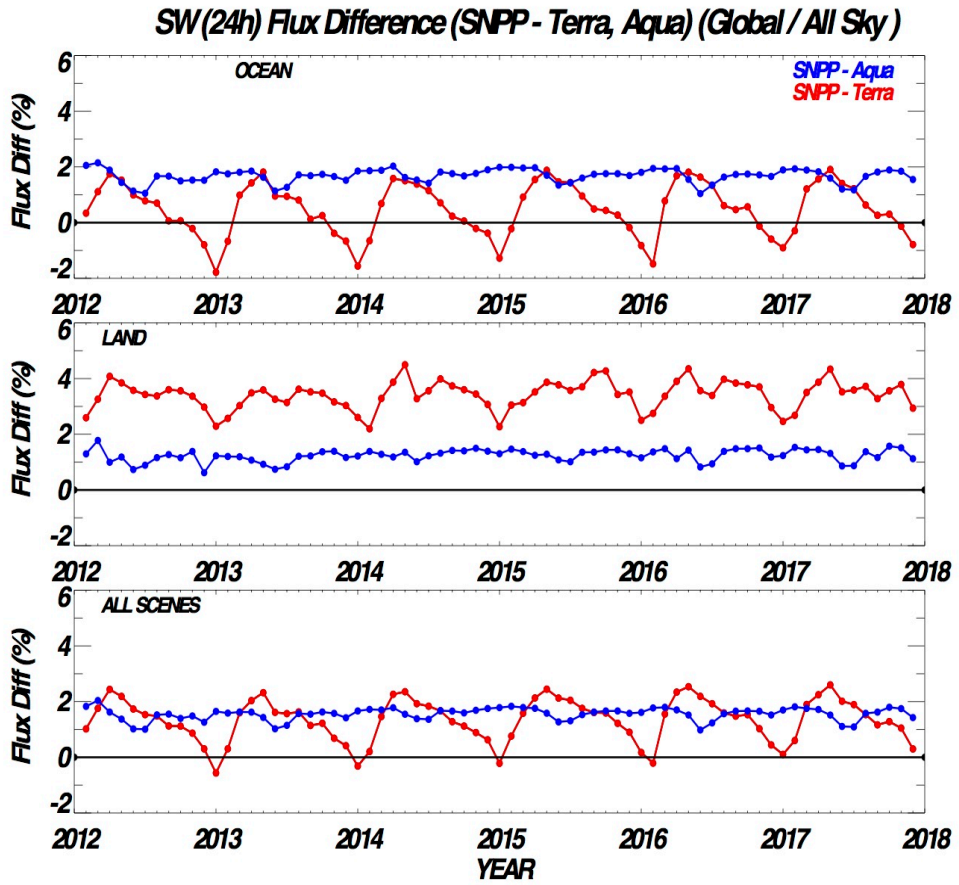




Tropical Mean LW Radiances (Day and Night) show minimal differences.
Global Flux Differences show that FM5 SW measurements are higher by ~1.5 Wm-2 and LW measurements lower by ~0.5 Wm-2.

S-NPP/FM5, TERRA & AQUA COMPARE: SW

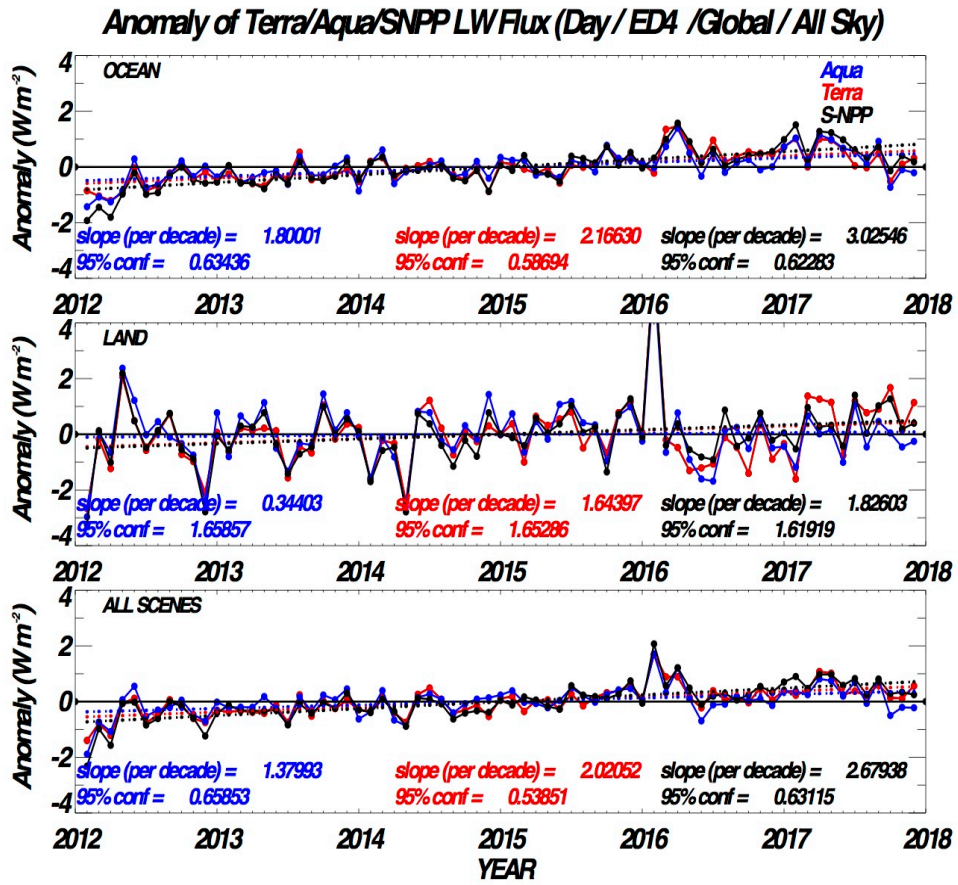


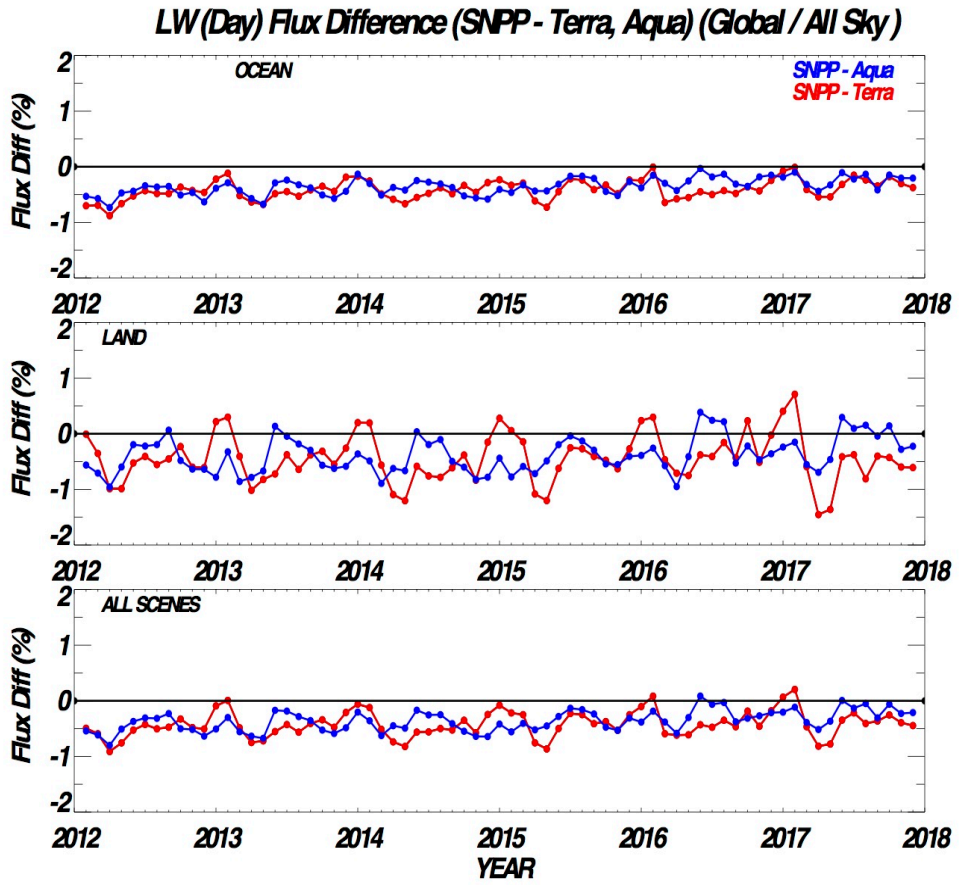


SW Flux anomaly for all scenes show similar trend for all instruments.

S-NPP/FM5 SW difference between Terra/FM1 and Aqua/FM3 remain stable.

S-NPP/FM5, TERRA & AQUA COMPARE: LW Day

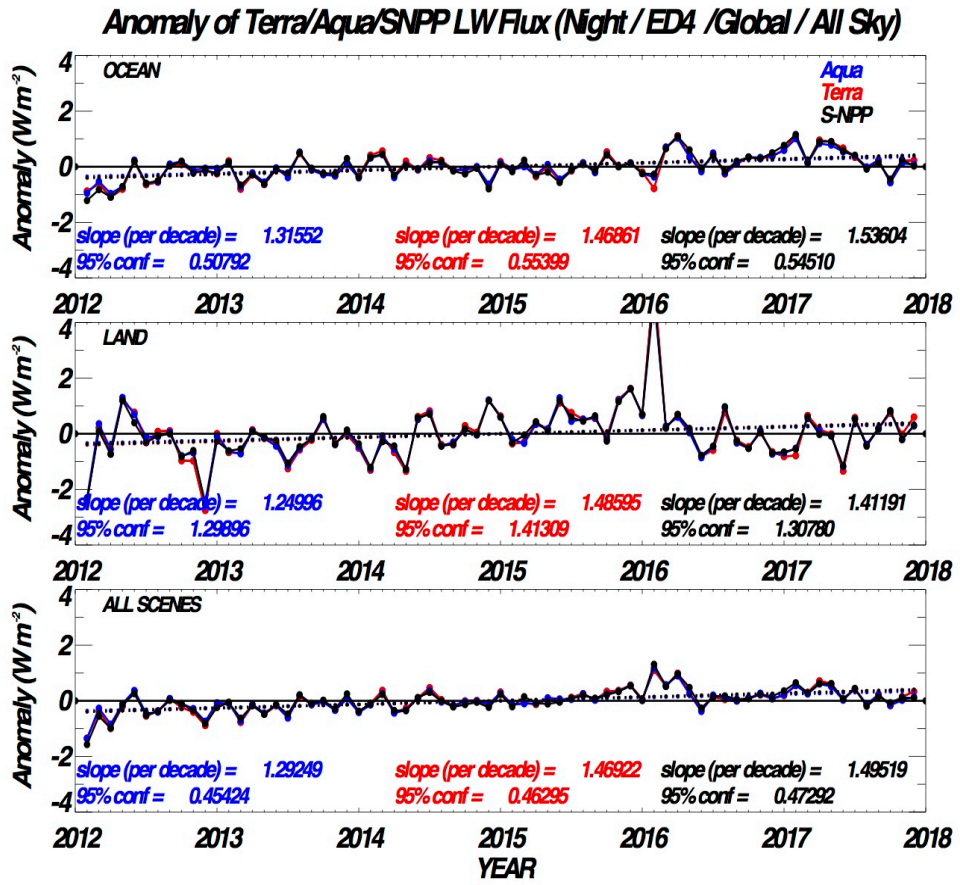


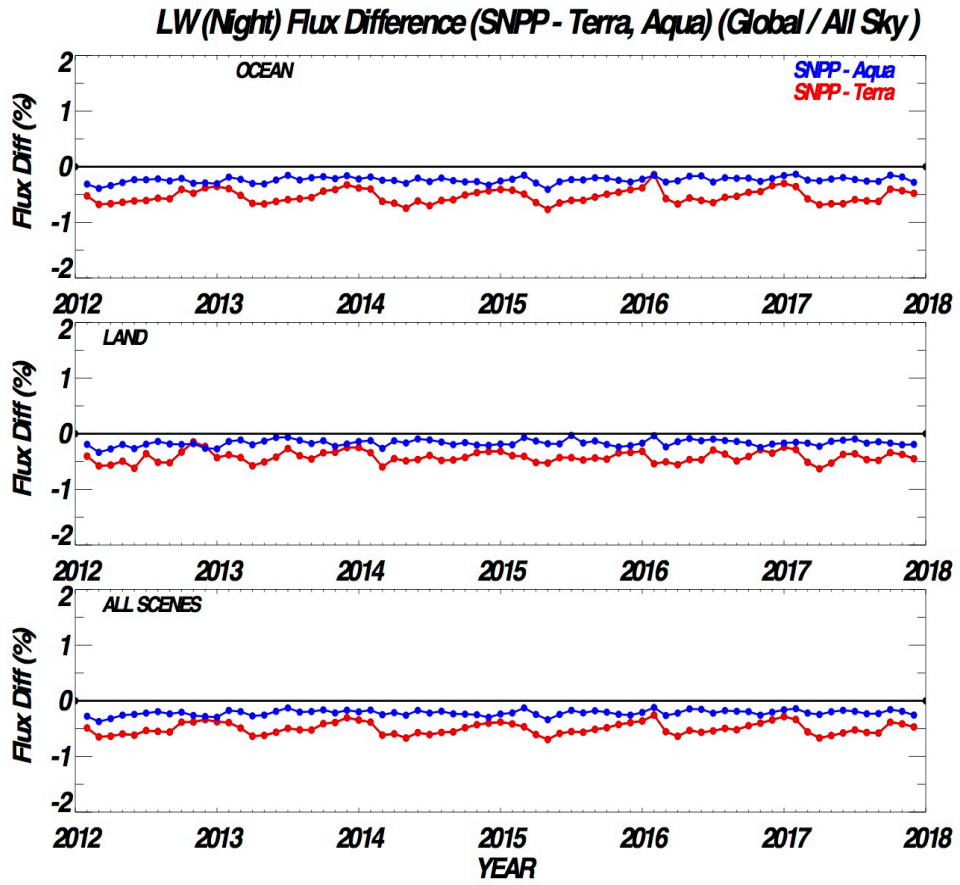


LW-Day Flux anomalies from the 3 instruments show similar trend.

Difference between S-NPP/FM5 with FM1 and FM3 LW_Day Flux show slight increase in trend.

S-NPP/FM5, TERRA & AQUA COMPARE: LW Night





LW-Night Flux anomalies show similar positive trend on all 3 instruments.
Difference comparison of S-NPP/FM5 with FM1 and FM3 measurement remain stable.

S-NPP/FM5 Edition2 Activities

- The intercomparison results between S-NPP/FM5 and Aqua/FM3 showed that SW radiances are higher for FM5 instrument.
- The Shortwave radiance difference between FM5 and FM3 for Clear Ocean scenes is relatively higher than SW radiance difference for All-sky scenes between two instruments.
- Re-evaluate Start of mission SW Spectral Response Function (SRF) for FM5 instrument to address the relative differences for various scene types.
- The SW radiances for FM5 instrument will get calculated with the new SW SRF.
- Intercomparison with FM3 SW radiance to determine the overall scaling factor for FM5 to bring NPP/FM5 and Aqua/FM3 instruments to a common radiometric scale.
- The revised Start of Mission SRF and radiometric scaling factor will get applied in NPP/FM5 Edition2 processing.

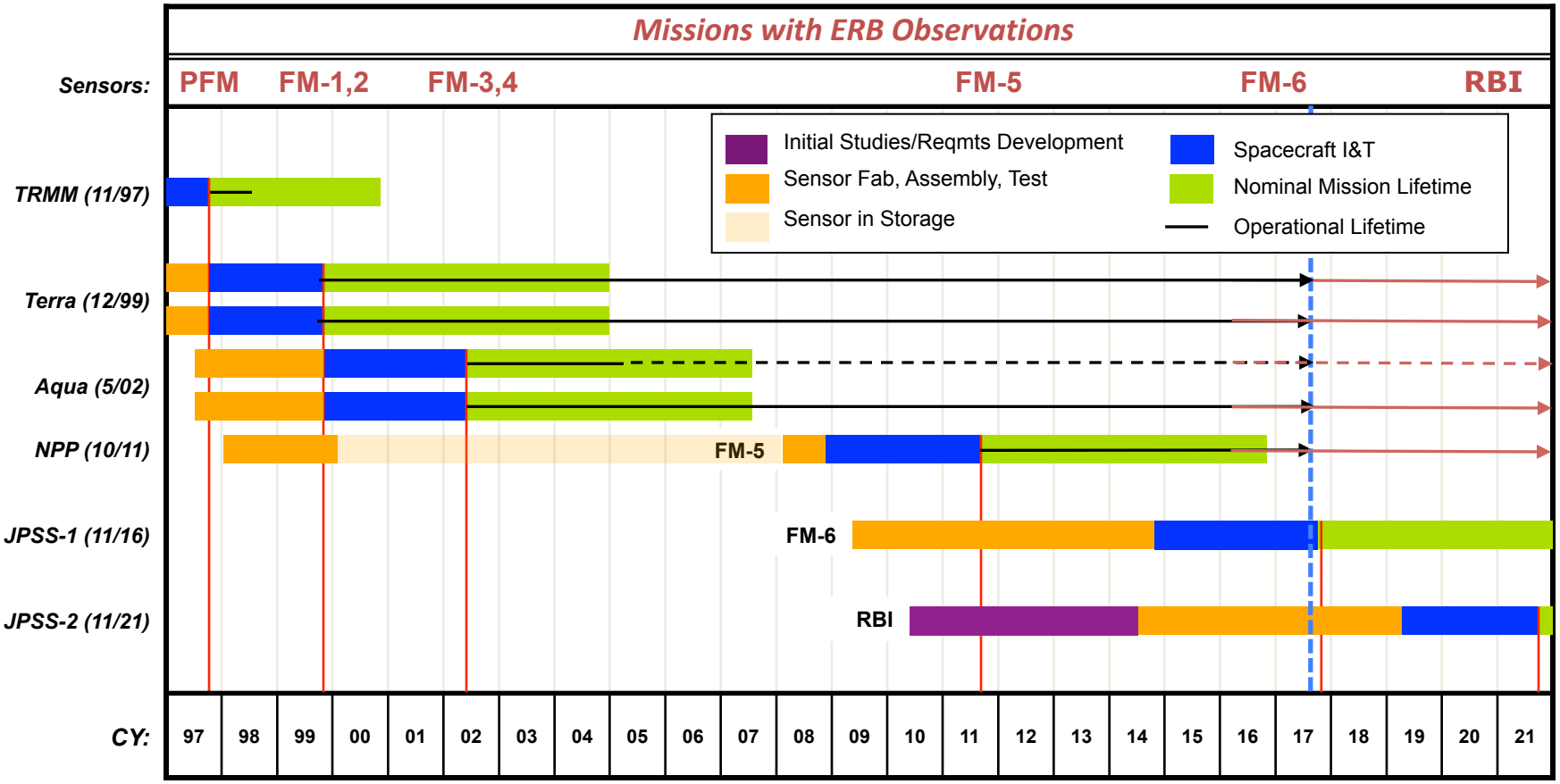
SUMMARY

- The Terra and Aqua Instruments' Gains and Spectral Response Functions for Edition4 processing were delivered through January 2018. Validation results of Terra/Aqua Edition-4 data show consistent trends in SW and LW measurement among the three CERES instruments (FM1 – FM3).
- S-NPP/FM5 calibration results are within the expected range. SW sensor results showed similar trends for MAM and SWICS Level1 calibrations.
- S-NPP/FM5 inter-comparison with Aqua/FM3 showed SW measurements are higher for FM5 instrument in comparison with FM3.
- CERES FM5 Start of Mission Spectral Response Function (SRF) is being reevaluated to address the differences between Clear ocean and All-sky scenes observed in inter-comparison studies between NPP/FM5 and Aqua/FM3.
- NPP/FM5 Start of Mission SRF changes and the radiometric scale difference with Aqua/FM3 will be included in NPP/FM5 Edition2 process.

BACK UP SLIDES

Climate Data Record Continuity

CERES/RBI Flight Schedule



We now have over 69 years of flight experience with the CERES instruments

Direct compare of FM5 and FM3

FM5–FM3 "simultaneous Earth" observation 2012/2013/2014/2015/2016

ΔTime < 1min; ΔRAZ < 10°; ΔVZA <10°

All-sky

Shown differences are statistically significant

(FM5-FM3)/ FM5	FM5 Radiance [W m^{-2} sr^{-1}]	Relative Error [%]	α-confidence [95%]	Number of samples
Shortwave	79 /85 /77 /81 /80	**3.3 / 2.7 / 1.0/ 1.7 /2.6**	.4 /.3 /.4 /.4 /.3	65/86/91/85/91
LW daytime	76 /74 /77 /77 /76	**-1.1 /-1.3 /-0.6 /-0.9 /-1.0**	.1 /.1 /.1 /.1 /.1	69/89/91/85/91
LW nighttime	66 /65 /68 /66 /66	**-0.3 /-0.3 /0.0 /-0.2 /-0.3**	.1 /.1 /.1 /.1 /.1	87/105/106/105/111

- Shown differences are computed as "average of differences" to avoid error cancellation